

# SMARA UPDATE



The Quarterly Newsletter of the Department of Conservation - Office of Mine Reclamation

## AML Report Released to Public

Since the Gold Rush of 1849, tens of thousands of mines have been dug in California. Many of these mines were immediately abandoned when insufficient minerals were found, others were abandoned later when poor economics of the commodity made mining unprofitable, while still others were abandoned in 1942 after the issuance of War Production Board Order L-208. The result is that California's landscape contains tens of thousands of abandoned mine sites, many of which pose health, safety, or environmental hazards.



Among those working on the AML report were (from left) **Karen Thomason, Sarah Reeves, Jon Mistchenko, Eric Miller, Steve Newton-Reed, Mike Tuffly, Gail Newton and Steve Reynolds.**

### CONTENTS

<i>Two New Board Members</i>	
<i>Appointed by the Governor.....</i>	<i>2</i>
<i>Stay Out - Stay Alive Program.....</i>	<i>3</i>
<i>Message from the Director.....</i>	<i>4</i>
<i>Some Close Calls for AMLU.....</i>	<i>4</i>
<i>Utilizing GPS Technology.....</i>	<i>6</i>
<i>Executive Officer's Report.....</i>	<i>7</i>
<i>Preservation and Conservation</i>	
<i>of Abandoned Mine Lands.....</i>	<i>8</i>
<i>Workshop Schedule to</i>	
<i>Conclude with Reclamation</i>	
<i>Plan Review Training .....</i>	<i>9</i>
<i>Financial Assurances Tips.....</i>	<i>10</i>
<i>AML Crossword Puzzle.....</i>	<i>11</i>
<i>Crossword Puzzle Answers.....</i>	<i>12</i>

In the October 1998 issue of *SMARA UPDATE*, you were introduced to the new Abandoned Mine Lands Unit (AMLU). AMLU was tasked by the legislature with determining the magnitude and scope of the abandoned mine problem in California. In 1997, the AMLU undertook a three-year effort to inventory abandoned mines which culminated in the release of its recent report entitled California's Abandoned Mines: A Report on the Magnitude and Scope of the Issue in the State. This report may be viewed by visiting the

department's web site at [www.consrv.ca.gov/omr](http://www.consrv.ca.gov/omr).

Prior to this effort, the reported number of abandoned mines was based solely on legacy databases and ranged from a low of 7,000 to a high of 20,000 abandoned mines. To get a more accurate picture of the nature and extent of this problem, existing literature and data were collected and spatially analyzed through the implementation of a Geographic Information System (GIS). Data gaps were identified, and a field program was implemented to

(Continued to page 2)

## AML Report Released to Public

(Continued from page 1)

address those gaps as well as acquire site-specific information. Data were collected at selected abandoned mine sites, by watershed, in various bioregions throughout the state. Significant mine features (surface workings, tailings or waste, and processing facilities) were photographed and precisely located by differentially corrected Global Positioning System (GPS). Standardized assessment and ranking protocol were applied to potential physical and chemical hazards observed. Field data, in addition to information collected from existing sources, were entered into a relational database and spatially and statistically analyzed for this report.

Following are the report's key findings:

- ◆ Based on field investigations and statistical extrapolations, it is estimated that there are approximately 39,000 (95% confidence interval from 29,300-69,800) historic and inactive mine sites in the state.
- ◆ Of these, 4,290 or 11% are estimated to present environmental hazards.
- ◆ Also 32,760 abandoned mines, or 84%, are estimated to present physical safety hazards.
- ◆ There are approximately 128,800 mining features (95% confidence from 102,700-160,600) in the state.
- ◆ Approximately 48,944, or 38%, of these features are hazardous openings (openings include adits, shafts, tunnels and other underground workings that open to the surface).

◆ Our research confirmed that a field visit to each site is necessary for assessment of physical hazards.

◆ Geo-environmental modeling can help prioritize field visits to sites with suspected chemical hazards; however, a field visit is necessary to confirm the existence and magnitude of these hazards.

◆ An estimated 50% of the abandoned mines are on private lands.

◆ Approximately 1.5% of the abandoned mines are on state lands.

◆ And 48% are on federal lands, primarily on Bureau of Land Management and US Forest Service property.

*Steve Reynolds,  
Acting Manager, AMLU*

*Editor's Note: The numbers listed in this article are based on statistical modeling and GIS analyses that are more fully explained in Volume II of the report. These numbers are subject to change as more data are gathered and the models subsequently refined.*

## TWO NEW BOARD MEMBERS APPOINTED BY THE GOVERNOR

On April 14, 2000 Governor Gray Davis announced the appointments of Allen M. Jones and Robert Griego to the State Mining and Geology Board.



*Allen Jones signs the paperwork making him an SMGB member as DOC Director Darryl Young looks on.*

Allen Jones, of San Diego, has served as Vice President of the H. G. Fenton Company and the Western Salt Company since 1990. From 1981 to 1990, he worked for the City of San Diego as Deputy Planning Director and Chief of Staff for City Council Member Bob Filner. Mr. Jones is a member of the American Planning Association, the Urban Land Institute, and the San Diego County Air Pollution Control District Hearing Board. He has a bachelor of arts degree from the University of California, San Diego and a master of science degree from Colorado State

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## Two New Board Members Appointed by the Governor

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University. Mr. Jones holds the board position of a member with background and experience in mineral resource conservation, development, and utilization.

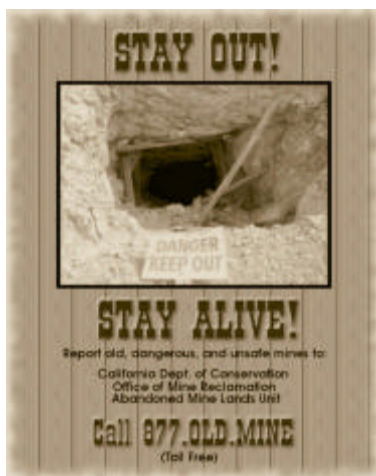
Robert Griego, of Bonita, has an extensive background in urban planning and local government. He is the General Manager of the Otay Water District, which serves south San Diego County. Mr. Griego previously was the City Manager for the City of Irwindale. He is a member of the International City County Management Association, the American Society for Public Administration, and the League of



*DOC Director Darryl Young (right) welcomes Robert Griego to the State Mining and Geology Board.*

California Cities. Mr. Griego has a bachelor's degree in education from San Diego State University and a master's degree in public administration from the University of California, Los Angeles. Mr. Griego fills the board's position as a representative of local government with background and experience in urban planning.

*John Parrish,  
Executive Officer, SMBG*



Abandoned mine lands pose a significant health and safety risk to the public and the environment. Significant features found at abandoned mines include tailings ponds and dumps; waste rock dumps; mine adits, shafts, pits, and quarries; processing mills and production equipment; miscellaneous buildings and structures; chemical or fuel storage (drums or tanks); fencing; trash; and miscellaneous power supply items and machinery (hoists, poles, transformers, lines, etc.). Abandoned mine shafts, adits, quarry highwalls, waste dumps, machinery, and structures present collapse or falling hazards. Shafts, adits, and trenches can contain poisonous, flammable, or oxygen deficient air. Subsidence and collapse of underground workings can cause property damage and pose falling hazards. Tailings ponds and other impoundments can present drowning hazards. Unstable abandoned explosives can also be found at abandoned mines.

Abandoned mines may contain toxic or hazardous chemicals such as cyanide (Cn) and mercury (Hg) left behind after ore processing. Arsenic (As) and

acid rock drainage (ARD) may be present, resulting from the chemical reaction and weathering of waste rock. These sites may also contain asbestos-laden construction materials and waste rock, as well as radioactive, flammable or other toxic chemicals that may have been stored or illegally dumped. These chemical hazards can present both acute and chronic exposure hazards from physical contact, ingestion, or inhalation.

Abandoned mines can also cause significant off-site environmental degradation and pose hazards to plant and animal life from erosion, sedimentation, mercury contamination and ARD.

Abandoned mines also provide food and shelter for a variety of wildlife, and as a result attract dangerous predators such as rattlesnakes and mountain lions. Because of these hazards, it must be emphasized that entering abandoned mines is extremely dangerous, and should never be attempted by other than properly equipped and trained mine safety inspector teams.

In California, contemporary mine operators are required to reclaim mined lands in accordance with SMARA. However, there are no state or federal laws requiring the reclamation of mines abandoned prior to SMARA, unless they are causing impacts to water quality. As a result, less than two percent of the abandoned mines in California have been mitigated or remediated. With no programs in place to address this problem and due to the costs involved, the majority of chemical and physical

*(Continued to page 5)*

## Message from the Director



**Darryl Young**

As legacies go, 39,000 abandoned mines surely isn't one of California's finest. Yet that's the figure we have to look at as we ponder the future of these potentially dangerous relics of a bygone era.

Thanks to the diligent work of the Department of Conservation's Abandoned Mine Lands Unit, we now have a much more realistic picture of the number and nature of the state's abandoned mines. The three-year AMLU effort, which included limited site evaluations and numerical extrapolations to count and characterize mine sites, culminated in an eye-opening report. The number of abandoned mines, the report says, is at least double what existing databases indicated.

More important, about 90 percent of the sites are believed to contain physical hazards. I've never personally fallen down a mine shaft or had a tunnel collapse on me - I'm a firm believer in the "stay out, stay alive" approach to abandoned mines - but I have

visited abandoned mine sites and can see how accidents could happen. As more and more people move into former mining areas such as the Sierra Nevada foothills, the danger grows exponentially.

In addition, the report tells us that 11 percent of the sites - almost 4,300 of them - present environmental hazards. Contaminated runoff from such sites can affect land, groundwater, streams and lakes. Some of these mines are on the U.S. Environmental Protection Agency Superfund list.

So what's next? As the self-help gurus like to say, it's not what happens to you, it's what you do about it. This much we know: the miners and mining companies who created most of these sites fifty or a hundred years ago aren't coming back to fill in the holes or clean up the tailings.

Each of us has benefited greatly from the goods and jobs produced by the mining industry. Today, the industry is high-tech and generally works with an eye toward public and environmental safety. Still, we have a physical legacy to address, one that figures to be costly and time consuming. How we choose to deal with that physical legacy will be the societal legacy we leave for future generations. It is incumbent upon all who benefit from mining in the present to take action on issues remaining from mining's past.

## Some Close Calls for AMLU

Abandoned mine sites can present a variety of hazards. Despite extensive training, even experienced AML investigators can be caught by unforeseen hazards. For this reason, and the examples that follow, the Abandoned Mine Lands Unit would like to emphasize its commitment to safety and the implementation of a health and safety plan that addresses abandoned mine hazards and their avoidance. During the three-year effort to inventory abandoned mines, AMLU investigators encountered a number of hazards during their field investigations. Fortunately, other than a few scrapes and bruises, no one was seriously hurt. Following are brief summaries of some of their "near miss" experiences.

During the first year of surveys, an experienced investigator underestimated the stability of a mine dump. While standing on it, the sloped surface gave way beneath him and sent him off a ten-foot bank. He landed on his back in a manzanita bush.

In another case, an investigator demonstrated the need for steel toe boots during a trip to the New York Mountains in the Mojave Desert. While climbing a slope to investigate a mine feature, a large boulder that appeared to be stable, rolled onto his foot, pinning him. A field partner supported the boulder and allowed the investigator to slip his foot clear and jump away as the boulder completed its roll down the slope.

*(Continued to page 5)*

## Stay Out - Stay Alive Program

*(Continued from page 3)*

hazards present at abandoned mines are not likely to be eliminated in the foreseeable future. For this reason, additional efforts are needed to educate the public about these hazards, and to inform property owners, government agencies, and the public of specific known hazards and the risks they pose.

Local governments and private organizations are strongly encouraged to join with OMR in participation in the nationwide mine hazard awareness campaign known as, "Stay Out - Stay Alive." This initiative is sponsored by the Federal Mine Safety and Health Administration (MSHA), and 30 other mining states to increase public awareness about the hazards of abandoned mine sites. This is a cooperative venture to provide educational materials to schools and the public through print, radio, television, and the Internet, regarding the hazards of abandoned mines. Abandoned mines attract the curious, which include children and teenagers, as well as adults. There are too many documented cases where those who have sought to "explore" abandoned mines have ended up dead or severely injured. OMR has begun its "Stay Out and Stay Alive" program by issuing a press release on mine hazards and providing a toll-free phone number (1-877 OLD MINE) for the public to report unsafe abandoned mines. OMR has also provided staff and resources for media coverage, which resulted in

several newspaper stories and television news programs about the hazards posed by abandoned mines.

*Steve Newton-Reed,  
Research Specialist*

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## Some Close Calls for AMLU

*(Continued from page 4)*

Fortunately, the boot did its job and no injury was suffered.

During another trip to the Mojave, an investigation team learned first hand about unstable underground workings. They encountered an unprotected



vertical shaft. To judge its approximate depth they tossed a cobble-sized rock into the shaft and timed its fall. However, the sound of the rock bouncing off the walls soon turned into a roar as subterranean structures were dislodged and fell, along with the rock, to the bottom of the shaft. When the dust settled, they estimated the shaft to be at least 200 feet deep.

On a site near the Clear Lake area, an investigator had the pleasure of a reptilian encounter that he will not soon forget. While clearing rocks and debris off an

access trail so that a group of people could pass safely into an area that was being reclaimed, he tipped one of the larger rocks on end and came face to face with a rattlesnake. He let the rock drop back into place and backed away before the snake could strike.

During a survey of an abandoned mine in Colusa County, an investigator received a whiff of "bad air" while approaching the mine opening or portal. The portal was partway up a slope and marked by a pile of tailings placed just outside the opening. As his face came level with the entrance, he immediately felt a burning sensation in his nose and became dizzy, nearly falling backwards from the fumes. Backing down the slope, he took several deep breaths to clear his head.

Finally, danger can present itself even before the mine site is reached. A team of investigators was navigating through the Tahoe National Forest in search of an historic mine when they became lost. It was a winter day and freezing fog had set in hindering visibility. The trees were too dense to use a compass for location and their GPS unit had stopped working. After some time trying to locate their bearings, the team was able to hike to a utility corridor identified on the map and followed this back to their vehicle.

The point of sharing these close calls is to underscore the fact that abandoned mines can be dangerous places, filled with many types of hazards. If you ever come across an abandoned mine, its best if you adopt the philosophy of **stay out and stay alive**.

*Jon Mistchenko,  
Student Assistant*

## Utilizing GPS Technology

The NAVSTAR Global Positioning System (GPS) is a powerful tool for navigation, surveying, and even setting the time for computer networks. A constellation of approximately 24 satellites orbiting the Earth, each continuously broadcasting signals containing its position, a time code and various other information, allows GPS receivers to triangulate positions. A minimum of three different satellite signals are required to triangulate a horizontal position, and four are needed to determine a vertical position. This system can be used to accurately locate features on the ground and, in conjunction with a Geographic Information System (GIS), can be used to create maps and provide spatial data used in various analyses.

Earlier this year, the Department of Defense (DOD) stopped degrading the civilian GPS signals. Up to this time, the so-called "Selective Availability" employed by the DOD caused readings of any single point position to be off by as much as 100 meters. Now, with "Selective Availability" turned off, a single reading will have a horizontal accuracy of about 10 to 15 meters. With techniques such as position averaging and differential correction, accuracy can approach the 1-meter level or less, depending on the equipment used. What this means for the more casual user (e.g. not surveyors or rocket scientists) is navigation to and from locations, and the

recording of positions is sufficiently accurate that even inexpensive receivers (\$100-\$200) may be used.

However, all this talk of accuracy will be meaningless if you don't pay attention to the datum, projection and coordinate system you are using. By design, GPS uses the World Geodetic System of 1984 (WGS 84). This system uses a worldwide-unified horizontal and vertical datum. Typically, receivers will display positions as latitudes and longitudes with elevation given in meters above (or below) the reference ellipsoid. The temptation might be to read this location and compare it to a position on a printed map. However, a position given in latitude and longitude relative to WGS 84 may be significantly different from a latitude and longitude given relative to the North American Datum of 1927 (NAD 27), which is common on many older maps. Luckily, most receivers can be programmed to display coordinates using a number of datums, projections and coordinate systems. When comparing coordinates between a GPS receiver and a printed map, always read the fine print describing the datum and projection. Then set your receiver appropriately. When collecting readings for future use, always record these items as well. Otherwise, the data may become useless. When reporting coordinates for a mine site to OMR, we request they be given in degrees, minutes, and seconds format utilizing the North American Datum of 1927 (typical of most USGS quadrangle maps).

Here are some ways a SMARA inspector might utilize GPS:

- ◆ Determine whether an operator is operating within approved boundary limits.
- ◆ Determine the area of "features" like pits or quarries by delineating the bounding polygon and analyzing it with a GIS.
- ◆ Determine volumes of waste or material stockpiles. This can be done by delineating the bounding polygon in three dimensions, collecting points of local extrema and slope change, and then creating a Triangulated Irregular Network (TIN) or an interpolated grid within a GIS.
- ◆ Collecting feature positions for later use with aerial photography, satellite imagery, or other GIS data layers.



Handheld Garmin 12XL  
(~\$250)



High precision survey-grade  
Corvallis Microtechnology  
CMT Z33 Package (~\$1500)

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## Utilizing GPS Technology

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The National Imagery and Mapping Agency (<http://www.nima.mil>) has many geodata products and related publications. Of interest are "Geodesy for the Layman" and Technical Report 8350.2 (DOD World Geodetic System 1984). NIMA has also made available the GEOTRANS coordinate "calculator" software for unix and Windows platforms. It translates coordinates between a large number of datums, projections and grid reference systems.

"The Geographer's Craft" is a web site with lecture material and various papers on GPS, GIS, datums, coordinate systems, projections and other related items (<http://www.Colorado.EDU/geography/gcraft/contents.html>). It is an excellent resource, and appropriate for the beginner.

The Army Topographic Engineering Center (<http://www.tec.army.mil>), like NIMA, has several publications relating to GPS usage. Many of these publications are technical and highly detailed.

Manufacturers of GPS receivers include:

Garmin International  
(<http://www.garmin.com>)  
Trimble Navigation  
(<http://www.trimble.com>)  
Magellan  
(<http://www.magellangps.com>)  
Conexant  
(<http://www.conexant.com>)  
Corvallis Microtechnology  
(<http://www.cmtinc.com>)

Eric Miller,  
Environmental Specialist

## Executive Officer's Report

At its June 15, 2000 regularly scheduled business meeting held in Sacramento, the State Mining and Geology Board took the following actions on these SMARA issues:

1. Adopted Resolution 2000-04 certifying the County of Tulare's Surface Mining Ordinance Number 3238. This new certification is the result of the board's program to encourage lead agencies with pre-1991 ordinances to bring their ordinances into accordance with current SMARA.
2. Approved financial assurances in the amount of \$86,929 for Granite Construction Company's Garnet Pit, located in the City of Palm Springs. The city has not yet adopted a surface mining ordinance, and the board is the acting lead agency.
3. Accepted a Division of Mines and Geology Open File Report 2000-04, *Mineral Land Classification of the KRC Holdings, Inc., M & T Chico Ranch Site, Butte County, California, for Construction Grade Aggregate Resources*. These newly classified mineral lands were the result of a petition for mineral classification received by the board from the prospective operator.
4. Granted a conditional approval of financial assurances for Sha Neva's Plant #2, in the Town of Truckee. The operator had already posted a financial assurance; however, the board believed the amount of the financial assurance was not adequate to reclaim the site according to the reclamation

plan and requested the operator revise the amount. The board provided information on specific areas where it believed the financial assurance needed to be revised. The Town of Truckee has not yet adopted a surface mining ordinance, and the board is the acting lead agency.

At its July 13, 2000 regularly scheduled business meeting held in the City of Irvine, the board took the following actions on these SMARA issues:

1. Adopted Resolution 2000-05 certifying the City of San Diego's Surface Mining Ordinance Number 18802. This new certification is the result of the board's program to encourage lead agencies with pre-1991 ordinances to bring their ordinances into accordance with current SMARA.
2. Adopted Resolution 2000-06 certifying the City of Los Angeles' Surface Mining Ordinance Number 17106.
3. Adopted Resolution 2000-07 certifying Lake County's Surface Mining Ordinance.
4. Adopted Resolution 2000-08 certifying the County of Contra Costa's Surface Mining Ordinance Number 2000-18.
5. Adopted proposed regulatory language to add Article 13, Selection of Professional Service Firms, to the California Code of Regulations, Title 14, Chapter 8, Subchapter 1, commencing with Section 3920.
6. Adopted proposed regulatory language to amend Section 3550.13, Construction Aggregate Resources, Fresno Production-Consumption Region, of the California Code of Regulations, Title 14, Chapter 8, Subchapter 1,

(Continued to page 8)

## Executive Officer's Report

*(Continued from page 7)*

Article 2. This amended regulation defines the mineral designated lands in the area based upon recent Division of Mines and Geology updated reports.

7. The board heard an appeal from a San Bernardino County surface mine operator who received an administrative penalty from the Department of Conservation for alleged violations of SMARA. **Hearing: Old Henshaw Quarry, Robert Raney, Operator v. Director of Department of Conservation** (Case No. 91-360051-99A). The director had issued an administrative penalty in the amount of \$10,000 for the alleged failure to provide a lead agency approved reclamation plan and an approved financial assurance, as required by Public Resources Code Section 2207. In light of the evidence presented, which consisted of an administrative record submitted by the DOC, written correspondence and oral testimony from Mr. Raney's attorney, and oral presentations from San Bernardino County staff and DOC staff, the board found that the violations of SMARA in the director's notice and order to be true and correct. The board also found that, despite numerous offers of assistance and warnings from the county and the DOC, the operator for several years had not acted in good faith towards coming into compliance with SMARA. The board believed this allowed the operator an unfair competitive advantage over those surface mine operators who made the effort and paid the costs of compliance with the state and

local mining laws. Therefore, the board increased the administrative penalty to \$50,000 from its original \$10,000.

At its August 17, 2000 regularly scheduled business meeting held in Sacramento, the board took the following actions on these SMARA issues:

1. Approved a request by the San Diego Association of Governments (SANDAG) for exemption from the requirements of SMARA under PRC § 2714(f) for six offshore borrow sites. This SANDAG project is part of a beach restoration program between approximately the Cities of Oceanside and San Diego.
2. Adopted proposed regulatory language to amend Section 3704, Performance Standards, to the California Code of Regulations, Title 14, Chapter 8, Subchapter 1, Article 9. These changes update the regulations so they are in accordance with current statutes and practices.
3. The board held a public hearing to entertain presentations from the Department of Conservation, Yuba County, the Yuba Goldfields Access Coalition, and other interested parties regarding the administration of the Surface Mining and Reclamation Act in Yuba County. The coalition has raised strong issues with the DOC and the board regarding the implementation of SMARA in the county. The county presented an aggressive timetable for revising its SMARA program. The hearing was for informational purposes only, and no actions were taken; however, the board has requested the DOC provide a progress report during the board's October meeting on the county's performance.

## Preservation and Conservation of Abandoned Mine Lands

The most common perception, and a correct one, is that abandoned mine lands present grave physical and environmental hazards. However, they may also contain resources of a unique and irreplaceable natural and cultural significance. These include threatened and endangered plants and animals; historical and cultural artifacts and infrastructure; unique geology and landform features; and mineral and paleontological resources. As such, these valuable resources need to be protected from destruction, vandalism, and theft.

The National Historic Preservation Act established the National Register of Historic Places (NRHP) as a federal listing of cultural resources worthy of preservation. The NRHP is maintained by the National Park Service, and to be eligible for listing, abandoned mine lands must be demonstrated to have significance to American history, architecture, engineering, or culture. The NRHP nomination process uses additional criteria to determine the historic significance of sites, buildings, structures, and objects. Besides meeting one or more of the NRHP criteria, a mine site generally must also be at least 50 years old (with possible exceptions), and have integrity of location, design, setting, materials, workmanship, and association in order to be eligible for inclusion. If a site has been compromised by

*(Continued to page 9)*

## Preservation and Conservation of Abandoned Mine Lands

*(Continued from page 8)*

significant alterations, it may not be eligible. The California Register of Historical Resources Program recognizes and protects resources of architectural, historical, archeological and cultural significance, identifies historical resources for state and local planning purposes, and determines eligibility for grants. The California Historical Landmark registry includes sites, buildings, features, or events that are of statewide significance, and which have anthropological, cultural, military, political, architectural, economic, scientific or technical, religious, experimental, or other values. The California Point of Historical Interest Program is a registration that recognizes resources that are only of local or countywide importance. All three of the California programs offer limited protection under CEQA.

Historical mine sites and museums are popular with the public and provide an invaluable resource for California tourism and education. Their preservation makes economic sense for communities by creating jobs and stimulating the local economy.

Abandoned mines also provide critical habitat for a wide range of plant and animal life, including some rare, threatened, or endangered species. Several species of endangered plants have been found in disturbed mining areas. Large mammals such as bears and mountain lions may use old adits as dens, and for winter



*Historical Gold Bug Mine in El Dorado County has become a popular local park*

hibernation. Other species such as the desert tortoise, rodents, owls, snakes, and salamanders also rely on mines for shelter. Bat species play a critical role in insect-control and pollination. Many bat species are threatened and endangered because uninformed development is destroying their habitat. Fourteen species of bats are known to use mines for roosts, winter hibernation, and nurseries in California. Ten of these are species of concern. Uninformed closure of mine openings without first conducting a biological survey could wipe out an entire colony of bats, and destroy the only habitat available for hundreds of miles. The preservation of abandoned mines as wildlife habitat may be crucial to the survival of certain species, so it is imperative that some effort be made to protect these unique and irreplaceable habitats.

*Steve Newton-Reed,  
Research Specialist*

## Workshop Schedule to Conclude with Reclamation Plan Review Training

This year's final workshop will offer training on the review of mining and reclamation plans. The workshop is being offered at no cost to participants and is scheduled to occur on October 19 at the Elihu Harris Building in Oakland. The workshop will be a one-day interactive training session with participants working in small groups to review two types of mining/reclamation plans. There will also be presentations from representatives from the Regional Water Quality Control Board, Department of Transportation - Bridge Structures, and the Department of Fish and Game. For further information on this year's final training session, please contact Andrew Rush at (916) 323-9198.

## Financial Assurance Tips



*Editor's Note: The following information was excerpted from Fundamentals of Earthmoving published by Caterpillar Tractor Company and is reprinted here courtesy of Caterpillar Inc. A basic understanding of these fundamentals is helpful when reviewing financial assurance cost estimates.*

### Materials

Earthmoving is the science of changing the lay of the land. The earth resists being moved, and the materials which make up the earth undergo a process of change as they are being moved. These changes are the result of the properties of the materials.

The prime question which concerns the earthmover is not about the nature of the material, but rather with its physical properties. He wants to know: "How easy is it to dig; to load?" He refers to this property as loadability.

The term loadability can only be explained as a general characteristic. If material digs and loads easily, it has a high degree of loadability. Conversely, if it is difficult to dig and load, we say that the material is not very loadable.

Certain types of clay and loam are considered very loadable.

They can be dozed or loaded into a scraper from their natural state. Other types of materials, such as rock or hardpan, must be loosened with a ripper or even blasted before they can be moved. The choice of the type of earthmoving equipment to be used on a job depends to a great degree on the loading (and unloading) characteristics of material.

The earth's surface is made of a sizable number of elements, compounds and mixtures, but the earthmoving contractor classifies materials as either rock material, soil material or rock-soil mixtures. Rock material is hard and firm like ledge rock, masonry and concrete structures, large boulders, and similar materials that may require drilling and blasting to remove. All other material is soil material.

Soil material is further classified by particle size and moisture content. For instance, gravel has large, coarse particles while clay has small, fine particles. Sand and silt are soils that have particle sizes in between these two extremes. Moisture retention properties also are quite important to the earthmover, since

moisture in soil affects its weight and handling properties.

Rock-soil mixtures are the stuff we work with. This sort of material is found throughout most

of the world and is a combination of various rock and

soil materials. The name given to a mixture identifies its composition. For example, sandy loam is predominately loam with some sand mixed in it.

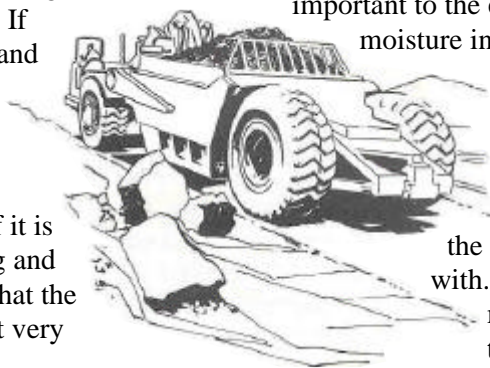
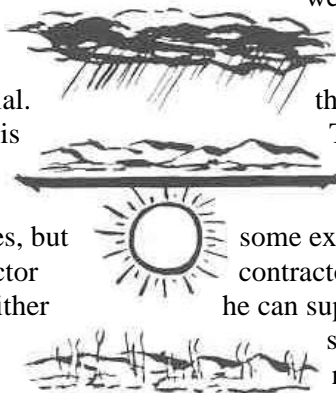
All material in the natural state usually has some percentage of moisture in it depending on the

weather conditions, drainage, and retention quality of the material itself.

These factors can be controlled by the earthmover to

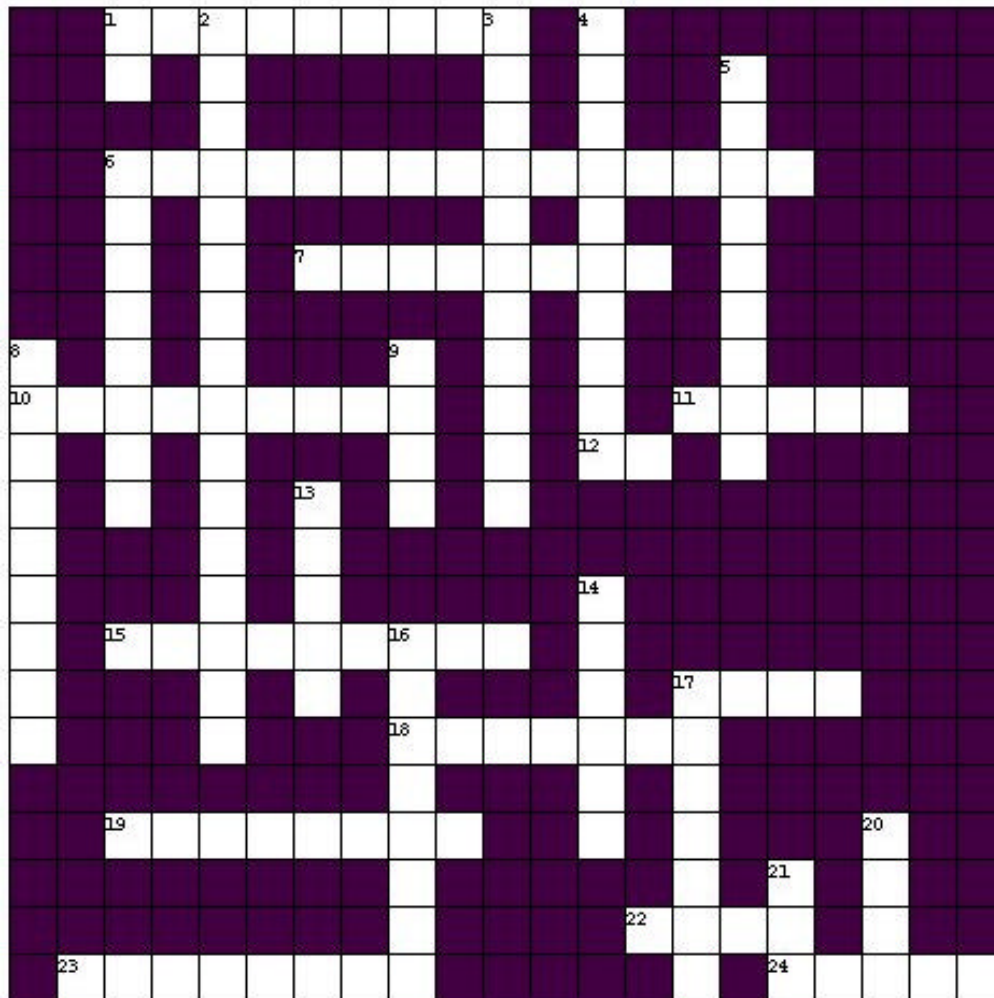
some extent. Although the contractor can't make it rain, he can supply water by sprinkler truck. If natural drainage conditions aren't

satisfactory, ditches can be constructed. The moisture retention quality of material can be changed sometimes, but this procedure is usually very impractical from an earthmoving viewpoint.



# AML Crossword Puzzle

by Sarah Reeves, Student Assistant



## Across

1. Mitigation of a mine
6. A toxic gas that has an odor of rotten eggs (2 words)
7. Rock failure in a mine
10. A mine that is no longer operating, has no financial assurance and no reclamation plan
11. An underground shaft that connects two levels
12. Chemical symbol for antimony
15. A structure over a shaft that lowers or raises men and equipment into a mine
17. Building where ore is processed
18. Wildlife friendly portal closure
19. 1849 event that sparked the mining industry in California
22. National Register of Historic Places (acronym)
23. Waste material separated from useful ore during processing
24. Heavy object used to crush extracted rock

## Down

1. Chemical symbol for arsenic
2. Condition produced when water and air comes in contact with sulfides (3 words)
3. Unauthorized entry into a mine
4. Dynamite and blasting caps
5. Type of mining that uses a high pressure water cannon
6. Excavation wall
8. Extracted rock that is not economical to process (2 words)
9. A horizontal opening
13. A vertical opening
14. Air that is oxygen deficient or contaminated (2 words)
16. Fibrous mineral that is harmful if inhaled
17. Element used to amalgamate gold
20. Mine Safety and Health Administration (acronym)
21. Global Positioning System (acronym)

## Puzzle Answers

(No cheating!)

### Across

- |                     |               |
|---------------------|---------------|
| 1. Abatement        | 17. Mill      |
| 6. Hydrogen Sulfide | 18. Batgate   |
| 7. Collapse         | 19. Gold Rush |
| 10. Abandoned       | 22. NRHP      |
| 11. Winze           | 23. Tailings  |
| 12. Sb              | 24. Stamp     |
| 15. Headframe       |               |

### Down

- |                       |              |
|-----------------------|--------------|
| 1. As                 | 9. Adit      |
| 2. Acid Rock Drainage | 13. Shaft    |
| 3. Trespassing        | 14. Bad Air  |
| 4. Explosives         | 16. Asbestos |
| 5. Hydraulic          | 17. Mercury  |
| 6. Highwall           | 20. MSHA     |
| 8. Waste Rock         | 21. GPS      |

The *SMARA Update* is a quarterly publication of the Department of Conservation's Office of Mine Reclamation, 801 K Street, MS 09-06, Sacramento, California 95814, (916) 323-9198. Our web site address is <http://www.consrv.ca.gov/omr>. The purpose of this publication is that of imparting the latest in reclamation tips, as well as changes in legislation or interpretation of existing statutes by court decisions.

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